The medical uses of radon

Eszter Deák MD, Katalin Nagy MD PhD
Markhot Ferenc Hospital, Dept. of Rheumatology, Eger

VII. Hungarian Radon Forum and radon in environment satellite workshop
16-17. May, 2013
Therapeutic experiences before the discovery of radon

- Palaeolithic findings near The Gastein sources, Austria
- Italian island Ischia, in the volcanic area around Naples, settled by Greeks 2500 years ago has been the first place in which warm radon sources have been used
- Antique artificial caves and bathing tubs with high radon concentration
- Famous old spas in the alpine regions of northern Italy such as Merano and Lurisia date back more than two thousand years to ancient Roman times
- In other cultures such as Japan, the radon effect (e.g. in Misasa) has also been a matter of empirical experience for many centuries.
First written documents on health effects observed in Ischia are by Gulio Jasolino in 1559 on “the natural therapy on the island Ischia”

Steben, Germany, with records of “strange properties” of a radon source from 1473, and the medical properties of this source described in 1690.

Paracelsus devoted a chapter of a book on health sources to “bat Castein” (Bad Gastein/Austria) in 1525-1527

Since the Middle Ages miners in the silver mines of Saxony, Germany and nearby St. Joachimsthal in Bohemia frequently suffered from lung diseases but had less problems with arthritic and similar diseases than the rest of the population.

There are numerous other locations now known as radon therapy facilities which have already been used as spas long before knowledge of ionizing radiation and radon.
Scientific studies on radon sources and therapy

Radioactivity by a French scientist A.H. Becquerel [1852–1908]
1898 the discovery of radium $^{226}\text{Ra}$ by Marie Sklodowska-Curie and her husband Pierre Curie
1900, a daughter product of radium, radon [Rn-222] was discovered by a German chemist F.E. Dorn who called it “radium emanation”

In 1904, in Bad Gastein, physicist Mache (after whom the first unit for radon concentrations was named) tested 15 natural springs and found varying, but in some cases very substantial concentrations of “emanation”.
In 1905, high concentrations in the waters and air in the uranium mines in Joachimsthal, which was the first reference to underground radon
In 1906, a list of the radon content in more than 30 sources in 11 spas in Austria, Bohemia, Germany and Italy has been published, with values up to 80,000 Bq/L in Gastein/Austria, 70,000 Bq/L in Baden/Germany, and 182,000 Bq/L in Schlema/Germany
In 1907, H. W. Schmidt, University of Gießen, Germany, reported high radon concentrations in residences
Between 1910 and 1940 radon therapy as popular fashion:

- external sources such as Ra-impregnated bed blankets and compresses
- radium was added to many “health food” items such as crackers, tea, coffee, and chocolate
- drinking radium or radon dissolved in water

The most radioactive of the commercially available waters were probably dangerous and many deaths may have resulted from their use.
Current status of radon therapy and randomized double-blind studies

Doubts: positive therapeutic and lung-cancer inducing effects

After 1990 randomized clinical prospective double-blind studies (with neither the patient nor the medical staff knowing about the identities of those in the control (placebo) and the radon groups, and with both groups treated under otherwise identical conditions)

Pioneering work was done in Schlema in 1992, and repeated in Bad Steben in 1995, by Pratzel of Munich University

Growing number of publications and lectures
Radon treatment centers with medical supervision

- Germany: Bad Brambach, Bad Kreuznach, Bad Münster am Stein, Schlema, Sibyllenbad, Bad Steben
- Austria: Bad Gastein, Bad Hofgastein, Bad Zell
- France: Plombieres
- Italy: Ischia, Merano,
- Russia: Pyatigorsk
- Japan: Misasa
- Hungary: Eger, Rudas
- Greece: Ikaria, Polichnitos spa
- Czech Republic: Jachymov
- China: Taishan, Nanshui
- Georgia: Tskhaltubo
- Poland: Świeradów-Zdrój, Czerniawa-Zdrój, Kowary, Łądek Zdrój
- Romania: Harghita Băi
Mechanism and pharmacokinetics of radon effects

Ways of radon uptake: inhalation (from natural sources like mines, caves)
  transcutaneous resorption (bathing in Rn-containing water, may be enhanced by concomitant heat or carbon dioxide)
  absorption (drinking radon water)

Radon is distributed in lipid-rich organs (e.g., nerve fibers, endocrine glands)

Radon daughter products are accumulated in the kidneys

The organ doses for a 15 min. bath at 1.500 Bq/L has been calculated at 0.1 mSv for the skin, 0.003 mSv for the kidney, and 0.0015 mSv for body fat.

Two hours after bathing, only 10% of the original radon intake remains in the body.
Physiological effects

- influence on Langerhans cells (antigen-presenting immune cells)
- stimulation of DNA repair enzymes
- increase in the endorphins level (pain-reducing effect)
- reduction of oxygen radicals in the neutrophiles and macrophages
- influences on homoeostasis
- stimulation of natural killer cells, anti-oxidant compounds
- decrease in C-reactive protein
- stimulation of the defensive immune system
- increased excretion of purin bases and uric acid in urine
- improvement in capillarisation
- activation of adrenalin secretion
- stimulation of genitals

Long-term exposure may lead to chronic pneumonia, lung cancer
Methods of radon therapy

- General radon baths
- Local (chamber) radon baths
- Bathing in swimming pools and piscines
- Air-radon baths
- Radon inhalations
- Radon water drinking
- Vaginal irrigations
- Micro-clysters
- Radon suppositories
- Underwater massage-shower using the de-emanated radon water
- Combined baths using water containing in addition to radon other essential balneal components (salts, gases and others)
- Steam-radon baths
- Radon oils or carbonic pills taking
- Injections of radon-containing fluids
- Rectal irrigations
- Oral and nasal cavities irrigations
- Head irrigations
- Radon applications; applications of radon by-products
- Compresses, wrappings, coverings with the use of radon water
- Visiting radon "emanatorium's"
Indications for radon therapy: musculoskeletal system

**Inflammatory diseases:**
- rheumatoid arthritis (minimum or medium degree of activity)
- ankylosing spondylitis (Bechterew's disease)
- systemic sclerosis (minimum or medium degree of activity)
- gout (in intermitting or chronic stage)
- psoriatic arthritis (minimum and medium degree of activity, with or without skin manifestations)

**Degenerative joint and spine diseases:**
- deforming osteoarthritis
- arthritis of traumatic origin
- osteitis, periosteitis
- spondylosis
- myosites, bursites, tendovaginites

**Rehabilitation after surgery on affected joint, spine, fractures**

**Fibromyalgia syndrome**

**Osteoporosis pain**
Therapeutic effects on musculoskeletal system

- reduction in pain
- reduction of inflammatory processes
- increase of mobility in joints
- improvement of the spine flexibility
- desensitizing effect
Indications for radon therapy: nervous system

Neurosis
Neurasthenia (transitional and hyposthenic form)

Peripheral nervous system:
1. neurologic appearances of vertebral osteochondrosis with clinically apparent pain syndrome of subacute and chronic history: cervicobrachial/thoracal/lumbosacral radiculopathy, patient's condition after ablation of herniated disk
2. neurites, polyneurites, including ischialgia and lumbar ischialgia
3. vegetative polyneuropathies: polyneuritis of occupational character (vibratory disease)
4. plexites
5. neuralgia
6. neurofibromyosites
7. sympathetic truncites

Central nervous system:
1. initial manifestations of cerebral atherosclerosis, residual effects and asthenic condition of a patient after encephalitis, diencephalitis, injurings and other craniocerebral injuries without gross organic symptoms, meningitis, meningoencephalitis, cerebral arachnoiditis, poliomyelitis
2. syringomyelitis
Therapeutic effects on nervous system

Radon procedures have noticeable analgesic effect

Radon helps reduce nerve inflammation and speeds up regeneration of a nerve fiber

Radon therapy has strong sedative effect on a central nervous system
Indications for radon therapy: dermatology

Psoriasis (forms - vulgaris, psoriatic arthropathia, verrucosa)

Local and disseminated neurodermatitis (acute, subacute, incomplete remission, remission)

Dermatitis (in acute and subacute stages)

Seborrheic (true) eczema (acute, subacute and chronic stages at disseminated and local characters of skin process)

Lichen ruber planus

Ichthyosis

Urticaria
Psoriasis: before and after radon bath
Indications for radon therapy: respiratory system

**Bronchial asthma** (atopic, infectious-allergic, combined)

**Chronic pneumonia** (I-III stages with asthmatic bronchitis, pneumosclerosis of I-III stage)

**Chronic sinusitis**

**Hay fever**
Indications for radon therapy: cardiovascular system

**Mitral valve diseases**: insufficiency of mitral valve; combined mitral heart disease with insufficiency of mitral valve

**Myocarditis**

**Coronary heart disease**: stable exertional angina pectoris of I and II functional classes; condition after old acute myocardial infarction in early rehabilitation period; condition after coronary artery grafting surgery in early rehabilitation period

**Atherosclerosis, cardiosclerosis**

**Hypertensive heart disease of I, IIA and IIB stages**

**Diseases of peripheric vessels**: obliterating atherosclerosis of limb's vessels, obliterating thromboangiitis (Buerger's diseases), endarteritis with blood circulation disturbance of I-II stages; phlebitis; thrombophlebitis of inferior limbs
Therapeutic effects on cardiovascular system

- improves cardiac muscle nutrition
- normalizes the arterial pressure (reduces increased pressure)
- slows down heart pulse
- increases the stroke and minute volume of the cardiac output
- antiarrhythmic effect
Indications for radon therapy: endocrine system and metabolic diseases

**Pancreatic diabetes** of II type, of light and medium severity degree, in compensation stage, of stable clinical course, including obesity of I-II degree

**Diffusive toxic goitre** of I-III degree, in compensation stage
Indications for radon therapy: gynecology

**Female genital chronic inflammatory processes:** metroendometritis, parametritis, salpingo-oophoritis with acute cicatricial-commissural changes

**Female genital chronic inflammatory diseases with hormone-dependent neoplasms:** chronic inflammatory diseases in combination with asymptomatic uterine myoma not exceeding 12-week-pregnancy-uterus size (subserous interstitial localization of nodes). Patient condition after supravaginal amputation on account of uterine myoma with unaffected menstrual cycle, as well as complications: hyperpolymenorrhea, algomenorrhea, acute abnormality of functional activity of ovaries, sterility

**Genital endometriosis** not requiring surgical treatment, complicated by menstrual function abnormality according to hyperpolymenorrhea type, ovarian dysfunction (caused by hyperestrogenia), high-grade pain syndrome. Sterility, functional tubal sterility (caused by hypertone and discoordination of uterine tubes)

**Dysfunctional uterine bleedings,** hormone cycle abnormality, anovulatory cycle
Therapeutic effects on female genital diseases

- improvement of blood circulation in small pelvis organs
- increase of a skin-pain sensitivity threshold
- significant anti-inflammatory effect
- analgesic effect

→ Favorably affects the general condition of a patient, including menstrual, reproductive and hormone ovarian functions
→ a positive effect has been observed in uterine and climacteric bleedings, and inflammatory lesions in small pelvis
Indications for radon therapy: urology

Chronic pyelonephritis.

Residual effects after inflammations in mail genitals

Orchitis, epididymitis

Prostatitis

Impotence
Therapeutic effects on urological diseases

- anti-inflammatory
- analgesic
- bacteriostatic (inhibits bacterial growth and reproduction)
- spasmylytic effect
- contractile smooth ureter muscle function strengthens
- decrease in uric acid level in blood
Indications for radon therapy: alimentary organs

Gastritis (with hypersecretion, normal secretion)

Stomach ulcer and duodenal ulcer (in the stage of incomplete remission or easing acute condition at absence of susceptibility to bleeding, penetration and suspicion of possible malignant change, at concomitant abnormalities of liver's functional status)

Post-resection disorders, reflux-esophagitis (of painful and dyspeptic forms, I-II severity grade)

Chronic colitis, enterocolitis and sigmoiditis of different aetiology (except tubercular and dysenteric) without stenosing
Therapeutic effects on gastrointestinal diseases

The radon water drinking procedure activates regeneration of a mucous stomach coat after resection, accelerates healing of gastric and enteric ulcer, and generally reduces gastric acidity.
Therapeutic effects in addition

Radon therapy has a normalizing impact on carbohydrate, mineral, cholesterol and water metabolism in human body.

Radon therapy helps to decrease the specific reactivity (allergy) while increasing immunity.

Radon therapy increases the organic resistance to infectious diseases.

It strengthens the anti-tumor immunity.

Radon baths accelerate skin epithelization of patients suffering from burns.
The longevity of the therapeutic effect of radon application depends on the form of disease, its stage and the condition of patient. It starts with the treatment course, peaks within 1,5-2 months and lasts on average from six to eighteen months.
Contraindications for radon therapy

- acute infections
- mental diseases
- frequent bleedings
- haematological irregularities
- pregnancy
- tumors and these diseases' suspects
- acute serious diseases of internal organs
- suppurative processes, open wounds
- active tuberculosis
- epilepsy of any origin
- radiation sickness
- alcohol is also forbidden during the treatment
Dose Levels

Annual effective dose equivalent to patients (assuming one sequence of radon treatments) is usually between 0.1 to 3 mSv (within the normal fluctuations of natural background exposure levels)

The treatment personnel (doctors, nurses) may receive up to approx. 100 mSv

The new “radon protection” regulations in several countries make it difficult or impossible to establish new radon treatment facilities there.

In others (such as Austria, Czech Republic, Germany) with a long tradition in this field, radon therapy with natural water or air sources is at least tolerated by the authorities, as long as the personnel working there is supervised by personnel monitoring devices according to the regulations for “radiation workers”, using passive track etching polymer detectors, or new electronic systems.
Among some other problems in the more widespread application of radon balneology are:

1. The radiophobic syndrome caused by anti-nuclear political and media campaigns scaring many potential patients.
2. National health insurance systems, with increasing financial problems due to the demographic and economic situation in Western Europe, are in the process of reducing their services by excluding from their coverage “natural treatments” such as mineral and radon spas.
3. Governmental organizations split between those responsible for radiation protection, and others in charge of public health. While the first promote the public “dangers” due to even low residential and professional radon exposures (Schüttmann 1997, Becker 2003), the health authorities are becoming reluctant to promote research in areas which some public health administrators still consider not part of evidence-based medicine.
4. The influential lobby of the pharmaceutical industry is more interested in promoting the profitable large-scale use of non-steroid antirheumatic drugs, and succeeded to convince most of the medical community of this form of therapy instead of exploring the drugfree and relatively inexpensive radon treatments.

Summary

The existing trials suggest a positive effect of radon therapy on pain in rheumatic diseases.

The benefits of adequately used low-dose radon exceed the lung cancer risk attributed to the inhalation of radon.

“It is the dose which makes a poison” Paracelsus

With respect to the potential clinical effect and given the increasing public interest in radon therapy, there is an urgent need for further randomized controlled clinical investigations with long-term follow-up.
Thank you for your attention!